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MAINTAIN MILK QUALITY BY DECREASING BIOFILM IN THE PIPELINE

V. Taylor

Biofilm is made from bacterial cells that can elevate the standard plate count and decrease the quality of milk as it flows through the pipeline. Biofilms are everywhere, from the plaque on your teeth to the slime on rocks in a creek to the slime that forms on the inside of a vase holding flowers. The medical and industrial communities have taken considerable interest lately in what biofilms are made of, how they form and how they thrive in adverse conditions.

WHAT ARE BIOFILMS?

Simply put, biofilms are layers of bacterial growth that have attached to a surface and developed a protective shell, which shields them from detergents and sanitizers. They can typically be found wherever there is a flow of water or organic liquid. But researchers in the field of microbiology are finding that biofilms are much more complex, existing as "cities" of one or more types of bacteria that work together to gather, process and remove nutrients from their surroundings. By understanding how they function, we are learning how to remove them.

When inert materials found in milking pipeline systems (such as stainless steel, rubber and PVC) are exposed to nutrient-rich organic material (such as water or milk), some bacteria, and the right amount of time and temperature, a biofilm will form. As milk flows through the pipe in a clean, stainless steel milkline, a very narrow zone between the liquid phase and the surface of the pipe moves at a very low velocity, allowing organic material to settle and deposit on the surface of the pipe. This is called "surface conditioning." Bacteria that are free flowing (planktonic) through the pipe are then able to attach themselves to these organic deposits. They accomplish this in various ways, by using the flagella or tails they use to move around with, by secreting a sticky substance called exopolysaccarides or by charged interaction with the pipe and organic material. Some bacteria can actually adapt to the conditions of the surface of the pipe by changing their biochemical properties to favour those conditions for attachment. Flow rate, temperature, pH, available nutrients and contact time between bacteria and the surface all play important roles in the adhesion of bacteria to the stainless steel pipe.

Once attached, the bacteria start to multiply and will collectively begin to secrete an extracellular polymeric substance (EPS). The EPS is what makes up the protective layer of the biofilm and provides resistance to chemical cleaners. The more bacteria present in the biofilm, the greater amounts of EPS are produced. The EPS forms a type of matrix that can trap other bacterial cells, debris and nutrients to help support the growth of the biofilm. When the matrix is formed and becomes mature, however, it becomes very difficult to remove, with maturation occurring, sometimes in a matter of hours or over a period of several weeks.

Growth of the biofilm can progress upwards, forming a mushroom shape, or can spread out along the pipe surface. Whatever the shape is taken, the biofilm allows channels for water and nutrients to pass through, and captures other bacterial cells, some of which could possibly be pathogens. Any type of bacteria can form a biofilm, water organisms such as *Pseudomonas* species being the most common and hardy biofilm formers, as well as *Salmonella* or *Listeria* organisms. It is important to note that biofilms can be made of several different types of organisms.

Mature biofilms can be visible to the naked eye, appearing as a white-to-grey or cream-coloured deposit on surfaces or as a dullness to the sheen normally seen on stainless steel surfaces. They can make smooth surfaces such as stainless steel feel coarse or rough, and when the surfaces are brushed or scraped, debris comes off. If the temperature of the wash water is too cool, fat deposits can be easily detected in the milklines when cream-coloured to colourless water beads on surfaces and feels like grease on the skin.

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REMOVING BIOFILMS

At the mature stage of the biofilm, the only ways to remove the biofilm are to increase flow rate, increase temperature, or scrub or brush.

Increasing flow rate

While increased flow rate will reduce the zone of low velocity that exists between the liquid and the pipe surface, biofilms will still form in this reduced zone. Once the biofilm grows beyond this zone, it is subjected to the shear forces of the liquid passing through the pipe, eventually sloughing or breaking off pieces of the biofilm and contaminating the milk in the line.

Increasing temperature

Increased temperature will loosen the biofilm layer, but excessively hot temperatures could cause other problems, such as baking the protein in the milk onto the pipe surface, giving bacteria an excellent conditioned layer for adhesion.

Physical action

If just detergents or sanitizers are used to clean a milkline that has a biofilm, the chemical agent in the detergent or sanitizer may be used up in attacking and destroying the matrix. By the time the chemical agent reaches the bacterial colony underneath the matrix, it may have become ineffective in killing off the cells themselves. Scrubbing or brushing will lift off the matrix and expose the bacteria underneath to the chemical detergents and sanitizers. Increasing the cleaner concentration for a short period may also help remove bacteria that have begun to form a biofilm.

Check with your dealer about increasing detergent or sanitizer concentrations during your wash cycles if you suspect a biofilm problem. Also check with your dealer about increasing the frequency of acid washing your milkline to remove a biofilm. Peracid, or paracetic acid (PAA), part of the family of peroxides, is an effective acid for cleaning milklines, as it is a strong oxidizing agent, does not foam and rinses well from stainless steel surfaces. Storage of chemicals is extremely important, as chlorine detergents can lose their cleaning strength if stored in a warm, moist area. Store detergents and sanitizers in tightly closed containers in a cool, dry place.

An important step in ensuring your wash cycles and procedures are effective is to check the hardness and quality of the water used to clean the milking system. Have your dealer perform a routine check of your wash system and check for pH and hardness of the milkhouse water (a water softener may be required to allow your cleaners to work properly). Test your milkhouse water quality at point of use (e.g., sink tap or hose) at least once a year for microbiological levels. If you notice changes in the smell or colour of the water, especially during spring and after heavy rainfalls or flooding, have it tested immediately.

Examine your milking system for dead ends in the pipelines, correct slope for proper drainage and sharp or rough spots in the pipes or at welded joints. Routinely check the vacuum trap, air lines, milk hoses, pulsators and pumps for cleanliness. Test vacuum levels regularly, check for loose-fitting pipes (for air intake, and bacteria, into the lines) and replace rubber parts such as inflations and gaskets at least once a year. Over time, chlorine can deteriorate rubber, which can lead to inking, where the rubber sheds a black "ink" on surfaces and eventually cracks, which harbour bacteria and allow the development of biofilms. Check the spray ball in your bulk tank to ensure it is not plugged and is spraying all parts of the tank well. Pay careful attention to the cleanliness of the outlet valve of the bulk tank; as the cleaning solution drains from the tank, brush the outlet valve well.

To reduce the chance of biofilm forming, follow the label directions for use of chemicals, maintain constant temperatures (at least 71°C), give detergents and sanitizers adequate contact time with surfaces and maintain adequate slug velocity through the pipeline during rinse cycles to ensure pipelines are cleaned effectively.

This Factsheet was authored by Vanessa Taylor,
Milk Quality Assurance Program Lead, OMAFRA, Fergus.

Agricultural Information Contact Centre
1-877-424-1300
ag.info@omafra.gov.on.ca

www.omafra.gov.on.ca

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